BIOTECHNOLOGY LABORATORY

PROGRESS REPORT

April 15, 1966

UPPER EXTREMITY PROSTHETICS RESEARCH

(Contract V1005p-9779 with U.S. Veterans Administration)

HUMAN TRACKING

(Contract N123 (60530)32857A with U.S. Naval Ordnance Test Station, China Lake, California)

SENSORY MOTOR CONTROL

(Grant VRA RD-1201N-64)

MYOELECTRIC CONTROL

(Contract No. AF-33(615)-1969 with U.S. Air Force)

Project Leader: John Lyman
Professor of Engineering and Psychology
Head, Biotechnology Laboratory

Engineering Department Report

66-20

DEPARTMENT OF ENGINEERING
University of California
Los Angeles

Report No. 66-28
April 15, 1966

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Department of Engineering
University of California
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BIOTECHNOLOGY LABORATORY STAFF

Professional Staff:

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Freedy, Amos	B.S.
Groth, Hilde	Ph.D., Associate Project Leader
Harper, Ray	B.S.E.E.
Lucaccini, Luigi	M.A.
Lyman, John	Ph.D., Project Leader
Mangelsdorf, Dave	B.S.
Smith, Russell	M.A.
Weltman, Gershon	Ph.D., Associate Project Leader Myoelectric Control

Professional Consultants:

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Mazet, Richard	M.D. VA Hospital Brentwoo
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Technical Aides:

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Dietch, Jerry
Kaplan, Absalom
Kopfer, David
Shechet, Robert

Secretary:

Ragland, Marjorie

Secretarial Assistant:

Reddie, Sue

EXPERIMENTAL SUBJECTS

Beauvais, John
Fein, Ronald
McCutcheon, Thomas
Notestine, Ronald
Schnug, George
Shiell, Walter
Simpson, Bill

FOREWORD

The research described in the Biotechnology Laboratory Progress Report was carried out under the technical direction of John Lyman and is part of the continuing programs in Upper Extremity Prosthetics Research, Human Tracking, Sensory-Motor Control and Myoelectric Control Research.

The Biotechnology Laboratory is part of the Department of Engineering of the University of California, Los Angeles. R. O'Neill is Acting Dean of the College of Engineering and M. Duke acts as his representative for research activities.

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I. UPPER EXTREMITY PROSTHETICS RESEARCH

Sponsor: U.S. Veterans Administration

Current Research Activities

1.0 Experimental Investigation of the Heidelberg Pneumatic Arm

The completed technical report is scheduled to appear in the Spring issue of the Bulletin of Prosthetic Research.

2.0 Experimental Investigation of the Northwestern Attitudinally Controlled Elbow

The completed manuscript has been submitted to the Bulletin of Prosthetic Research for consideration for publication. We are currently awaiting the decision of the editor.

3.0 Experimental Investigation of the French Electric Hand

Rewriting of a technical report continues.

4.0 Exploration of Minor Surgical Methods for Developing New Body Control Sites

Experimental results are being evaluated and will be documented in a technical report.

5.0 Exploration of New Harnessing Techniques for Transducers

No progress during this period.

6.0 Evaluation of Tentative Design Criteria for Externally Powered Prostheses

A report summarizing the tentative criteria is being prepared.

II. RESEARCH ON SENSORY MOTOR CONTROL

Sponsor: Vocational Rehabilitation Administration

Current Research Activities

1.0 Experimental Investigations of the AIPR Pneumatic Arm

The completed technical report summarizing the evaluation of this prosthesis will appear in the Spring, 1966, issue of the Bulletin of Prosthetic Research.

2.0 Experimental Investigations of Functional Muscle Isolation by Training

2.1 Phase 3 of the investigation outlined in the Progress Report (Oct. 1965) has been completed. This investigation involved determination of the adequacy of previously established site-signal combinations for controlling a high inertia arm simulator. Two subjects have completed tests consisting of one, two, and three-dimensional tasks. Primary reduction of the raw data is completed and a statistical analysis of the results is in progress.

Computer programs prepared by the Health Sciences Computer Facility, School of Medicine, UCLA are being employed for data description and data analyses. Computations are being performed at the Computing Facility, Department of Engineering, UCLA.

2.2 Three separate manuscripts summarizing results of this study are in preparation. The first will be a technical report summarizing the development of the logic system (see 3.0 below). The second report will summarize preliminary work resulting in the selection of muscle sites, transducer development and control modes. The third report will present results of the one, two and three-dimensional evaluation study.

3.0 Development of an External Logic System for Prosthetic Motion Control

A draft of a technical report describing the logic system is almost complete. The solid-state switching system used in phase three of the Muscle Isolation experiment improved the subject's performance considerably.

III. RESEARCH ON THE PERFORMANCE OF HUMAN OPERATORS OF TRACKING SYSTEMS

Project Administered by U.S. NOTS

China Lake, California

Sponsors: U.S. Naval Ordnance Test Station, China Lake, California

Naval Missile Center, Point Mugu, California

Department of the Army, White Sands Missile Range New Mexico

Patrick Air Force Base, Florida

Current Research Activities

1.0 Function Generator

The function generator is composed of two separate units the mirror drive system and the programmer. Since the last quarterly report, both of these devices have been modified for increased precision. The mirror drive system was found to oscillate in the azimuth dimension; by relocating the azimuth motor and gear box, the oscillation has been eliminated.

The programmer is a rapid switching device which increases or decreases the speed of the mirror drive motors by discrete resistance changes. In order for resulting functions to appear continuous, the time per switching from one resistance value to another must be optimum.

This has been accomplished by modifying the programmer's motor and gear box.

Two trajectories have been completed and three additional trajectories will be constructed shortly. Our facilities provide rapid switching between ten different missile simulating trajectories. Because plug-in printed circuit cards are used, these trajectories may easily be replaced by others.

2.0 Reports

Two technical reports of previous research are now in press and should be distributed within the next few weeks. Abstracts of these reports may be found on pages 9 and 10 of this report.

3.0 Experimentation

A four-part experiment investigating predictive behavior of the operator is scheduled to begin within two weeks. Accumulated results will be presented in forthcoming progress reports. Major interests in this study will be the evaluation of tracking performance as a function of (1) target losses, (2) acquisition-aiding devices, (3) trajectory irregularity, (4) operator expectancies of impending trajectories, and (5) experienced and non-experienced trajectories with similar dynamics.

The tracking facility is now completely operational. It is expected that further experiments will follow the present one with minimal delays. Designs for those studies are now being formulated.

IV. RESEARCH ON MYOELECTRIC CONTROL SYSTEMS

Sponsor: U.S. Air Force; ASD-Bionics Branch

Current Research Activities

1.0 Uni-dimensional EMG Control to a Self-Paced Input

This phase of the study has been completed. A final report of the results has been submitted to the contracting agency.

2.0 Uni-dimensional EMG Control to a Step Input

The final draft was submitted to the contracting agency for approval on February 28, 1966. Recommended changes have been incorporated and the final report was mailed to the contracting agency on April 28, 1966.

The abstract can be found under Publications.

PUBLICATIONS

Lyman, J., Groth, Hilde and Weltman G.

"Studies in Skilled Myoelectric Control". Air Force Avionics Laboratory Technical Report AFAL-TR-66-83, Wright-Patterson Air Force Base, Ohio, April 1966. UCLA Dept. of Engineering Report No. 66-25.

Abstract

Myoelectric (EMG) signal spectra were investigated and defined for a variety of conditions including different conditions of effort and fatigue. Cardioelectric (ECG) elimination techniques were investigated. Two experiments with uni-dimensional, graduated myoelectric control simulations were conducted to determine design parameters and human response characteristics. Multi-dimensional myoelectric control experiments were designed on the basis of the results of initial studies. An auxillary study on multi-dimensional control using an electro-mechanical manipulator was also undertaken. The obtained results indicate that the problem of EMG control is by no means solved.

Smith, Russell L., Garfinkle, David R., Groth, Hilde and Lyman, John

"Performance Studies on the NOTS-UCLA Tracking Simulator: Effects of Selected Controller Configurations and Transfer of Training". Biotechnology Laboratory Technical Report No. 33, UCLA Engineering Department Report No. 66-22, March 1966.

Abstract

An experiment was performed on the NOTS-UCLA Tracking Simulator to assess effects of selected tracking controllers and transfer of training. The controllers varied in extent of movement and strength of centering. Trajectory characteristics, trajectory direction and tracking dimension were also included as variables. The results showed that: 1) subjects who had gained experience with a strong-centering, movable controller rapidly transferred to pressure-type controllers; 2) naive subjects learned faster and performed better the greater the strength of controller centering; 3) trajectory direction had some importance only with naive subjects; 4) differences between azimuth and elevation scores were not significant; 5) no differences were observed between all strong-centering controllers when trajectory difficulty was moderate. Given a high inertia tracking system with strong controller centering and sufficient

Abstract (cont.)

practice, there appears to be little evidence favoring either pressure or movable controllers.

Smith, Russell L., Garfinkle, David R., Groth, Hilde and Lyman, John

"Performance Studies on the NOTS-UCLA Tracking Simulator: Independent Effects of Error Magnification, Field of View and Trajectory Dynamics". Biotechnology Laboratory Technical Report No. 34, UCLA Engineering Department Report No. 66-23, April 1966.

Abstract

An experiment was conducted on the NOTS-UCLA Tracking Simulator to determine the independent effects of error magnification and field of view on tracking performance. Magnification was achieved by either increasing the display gain or decreasing the subject-to-display distance (optical gain). In general, the results showed that: 1) the facilitative effects on performance of increasing display magnification were apparently due to the concomitant reduction in field of view rather than to magnification per s 2) differences in performance resulted from the same retinal magnification, contingent on the method used to obtain it; 3) display magnification had little affect on performance when used in conjunction with optical magnification.

PROFESSIONAL ACTIVITIES OF STAFF MEMBERS

January 23-24, 1966

Bethesda, Maryland. John Lyman participated in a meeting of the Biomedical Engineering Training Committee at the National Institutes of Health.

February 27-March 2, 1966

Boston, Massachusetts. John Lyman attended the MIT-NASA Working Conference on Manual Control.

March 3, 1966

New York, New York. John Lyman visited the Sensory and Prosthetics Aid Division of the Veterans Administration and conferred with Dr. Eugene F. Murphy, William M. Bernstock, and Anthony Staros.

March 22-25, 1966

Washington, D. C. Gershon Weltman attended the Third Symposium on Underwater Physiology and conferred with ONR personnel.

April 5-6, 1966

Lafayette, Indiana. John Lyman made a site visit to Purdue University for the Biomedical Engineering Training Committee of the National Institutes of Health.

April 12, 1966

Los Angeles, California. Gershon Weltman and Harvey Lomas presented a paper entitled, "What the Walls Say Today: A Study of Contemporary Graffiti", at the Neuropsychiatric Institute at the University of California.

VISITORS TO THE LABORATORY

January 20, 1966

Bob Pogrund, Physiologist, UCLA Public Health Department, University of California, Los Angeles.

Ingemar Petersen, Neurophysiologist, University Hospital, Goteborg, Sweden.

February 15, 1966

Worden Waring, Biomedical Engineer, Rancho Los Amigos Hospital, Downey, California.

Kenneth Foshay, Research Assistant, Rancho Los Amigos Hospital, Downey, California.

Dan Antonelli, Research Engineer, Rancho Los Amigos Hospital, Downey, California.

February 21, 1966

Michael Hall, Research Engineer, University College, London, England.

George Fulford, Orthopaedic Surgeon Royal National Orthopaedic Hospital, London, England.